EN - IT

Fluid Mechanics for Internal Combustion Engines and Turbomachinery

INSTRUCTOR: Annarita Viggiano

ACADEMIC YEAR: 2017/2018, Spring semester - ECTS: 9

SYLLABUS

Mathematical models for the study of turbulent reacting flows (41 hours)
Fundamentals of fluid dynamics: conservation equations. Compressible and incompressible flows. Reacting flows of multicomponent mixtures. Introduction to turbulence. Energy cascade and dissipation at small scales. Kolmogorov's universal equilibrium theory. Kolmogorov scales. Direct numerical simulation of turbulence. Reynolds averaged Navier-Stokes equations. Turbulence models: algebraic models, one-equation models, two-equation models. Favre averaged equations. Introduction to LES and DES. Thermo-fluid dynamics in combustion chambers. Turbulent combustion.

On-line educational material

- Instructor's notes
- http://climeg.poliba.it/course/view.php?id=51

Textbooks

- D.C. Wilcox, Turbulence Modeling for CFD, Dcw Industries, 2006.
- J.D. Anderson, Modern Compressible Flow: with Historical Perspective, McGraw-Hill, New York, 2002.
- J.B. Heywood, Internal Combustion Engine Fundamentals, McGraw–Hill, New York, 1988.

Numerical schemes for computational fluid dynamics (22 hours)
Computational fluid dynamics. Classification of PDE. Equilibrium problems and marching problems. Finite differences. Accuracy, consistency and stability of a numerical scheme. von Neumann analysis. Amplification factor. Modified equation: dissipation, dispersion and diffusion errors. Definition of convergence: Lax's equivalence theorem. Application of numerical schemes to the model equations. Finite volume methods. Computational grids. Initial and boundary conditions.

On-line educational material

- http://climeg.poliba.it/course/view.php?id=3

Textbooks

- J.C. Tannehill, D. A. Anderson, R. H. Pletcher, Computational Fluid Mechanics and Heat Transfer, Taylor & Francis, 1997.

Applications to design and analysis of propulsion and energy systems (18 hours)
Applications of CFD to design and analysis by using open source software .Computer simulations.

Useful links

- http://www.ubuntu.com/download/desktop
- http://www.openfoam.org/
- http://www.openfoam.com/

EDUCATIONAL GOALS AND EXPECTED LEARNING OUTCOMES

The purpose of this course is to provide advanced knowledge of applied thermo-fluid dynamics and of Computational Fluid Dynamics (CFD) and to introduce students to the use of CFD for design, analysis and optimization of energy and propulsion systems. At the end of the course, the students will be able to use advanced computational tools, both open source and licensed, to choose the proper mathematical models for the design of a specific component and the numerical methods for the solution of the equations.

EVALUATION METHODS

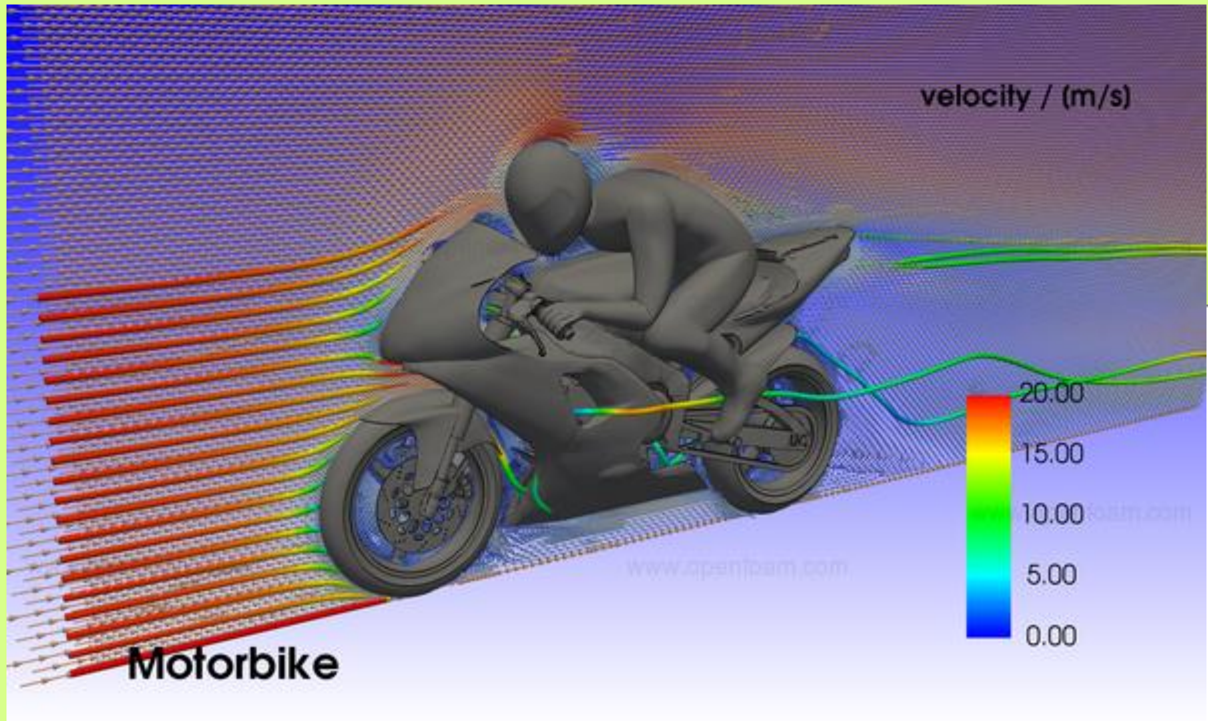
The examination consists of the elaboration of a project and an oral examination. During the development of the project, students have to apply the theoretical knowledge and software skills acquired during the lessons in order to design, analyze and optimize a component of a fluid system. The project is usually developed by a group of students and should be delivered a week before the oral examination. Each student will discuss the project during the oral examination, when the knowledge and skills acquired by the student, as well as his ability to solve problems, will be verified. The overall grade will take into account all stages of the examination.

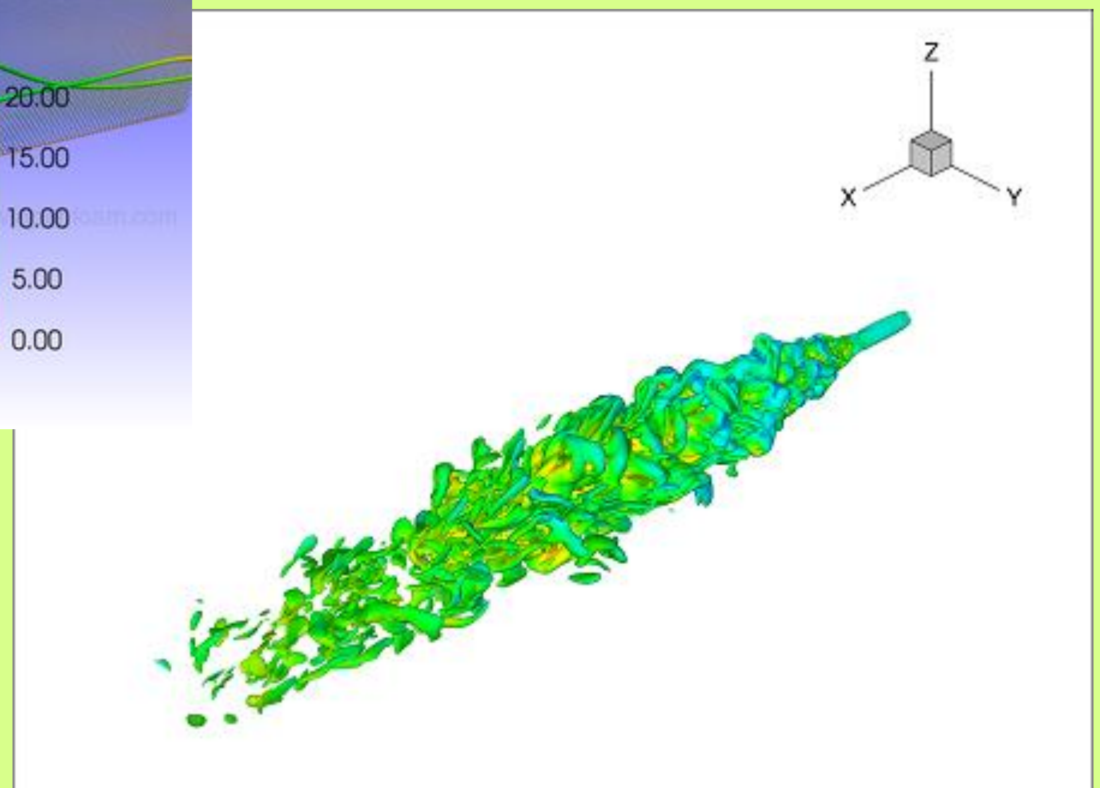
TENTATIVE EXAM SCHEDULE

19/07/2018; 27/09/2018; 25/10/2018; 29/11/2018

OFFICE HOURS

Thursday 12.00-14.00, School of Engineering, Office room 68, and in the classroom after class.





Large eddy simulation of a hydrogen jet: vorticity iso-surface coloured with Mach number values

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Bonelli F., Viggiano A., Magi V. (2013). AIP Conference Proceedings. vol. 1558, p.232-235.

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